PROGRESS REPORTS

FROM

EXPERIMENT STATIONS

SEASON 1956-1957

REPUBLIC OF THE SUDAN

PUBLISHED BY

THE EMPIRE COTTON GROWING CORPORATION

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PROGRESS REPORTS FROM EXPERIMENT STATIONS

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

1923-25 (one volume), 1926-1927, 1931-32, 1934-35, 1935-36, 1942-43 and 1945-46 to 1950-51.

From 1951-52 the reports from each territory were published individually each season. A few of the 1951-52 reports are out of print, but all others are available post free at 1/- per report or 7/6d. for the seasonal set.

ERRATUM: REPORT FOR 1955-56.

On page 10 of the 1955-56 Sudan Report the genes referred to in lines 15 and 16 came from the variety *Tanguis*, not *Ferguson*. Please make the necessary alteration to any copy in your possession.

REPUBLIC OF THE SUDAN

COTTON BREEDING STATIONS

PROGRESS REPORT FOR THE SEASON 1956-57

	Planting Dates.	*Picking Dates.*
Gezira	Mid August to mid September.	January to March.
Gash	Late August to late September.	Mid January to April.
Tokar	Early September to mid October.	January to May.
Kordofan	Mid June to mid August.	Mid October to February.
Zeidab	First half May.	September to December.
Equatoria	Mid May to August.	October to mid February.

Introductory Note

BY

M. F. ROSE.

General.

The position of the Corporation in the Republic of the Sudan was discussed with Government in Khartoum during the visit of Mr. J. C. May in December, 1956. After having been responsible for cotton breeding work in the Sudan for well over thirty years it is a source of great pride and satisfaction to the Corporation to have been invited to continue to serve the Republic in this way until Sudanese Scientific Officers should be available to take over.

As a member of the Sudan Scientific Advisory Committee, Sir Joseph Hutchinson arrived in Wad Medani on February 11th. The present cotton breeding programme was fully reviewed and future policy determined. The genetics section at Shambat was also visited and members of the staff there were given full opportunity to discuss and re-assess the value of the many lines of work in progress.

No staff changes were effected during the current season.

Tours.

In mid November, Mr. A. Low toured the cotton areas of the Eastern and Western Jebels; he was accompanied by Mr. J. H. Saunders. All cotton trials at the Kadugli Station were inspected and staff and administrative difficulties were discussed with those on the spot. In collaboration with the Manager, Nuba Mountains Cotton Industry, a new isolation area (approximately 500 feddans) was demarcated and prepared at Semeiha. This area should more than satisfy the full requirements of the Abu Habl if a major change in variety for the Nuba Mountains is to be made.

Commercial Cotton in the Sudan.

Areas and yield are given below:—

(i) *Egyptian Cotton*

	Area (feddans)	*Yield (kantars)*
Gezira	245,359	1,658,464
White Nile	150,710	801,345
Abdel Magid	10,040	57,041
Gash	68,603	78,472
Tokar	100,000	93,399
	574,712	2,688,721

(ii) *American Cotton*

Irrigated	7,599	22,304
Flood (Abu Habl)	3,965	5,577
Raingrown	149,703	144,841
	161,267	172,722
Total	*735,979*	*2,861,443*

One feddan = 1·038 acres. 1 kantar = 315 rotls = 312 lb. seed cotton.

The fall in American production has been markedly offset by increased areas and higher average output in the Egyptian crop. An overall increase of 39·6% (seed cotton) over the previous year's figure is noted and should put the gross bale production of lint (400 lb.) well above the 700,000 level. This is an all-time record.

The Gezira yield averaged 6·759 kantars per feddan, narrowly missing the 1950-51 record of 6·789. Sakel grades showed marked improvement but such was not the case with the L types.

The Gash flowed at very high levels and at one time Kassala town was seriously threatened by flood waters. An area of 250,000 feddans was under water, which allowed extensive cultivation on the 'Gash dai'. In consequence the effective cotton area in the Gash was almost double that of the previous year: average returns were poor, and this can be ascribed to a very cold spell in January (with frost burn) followed by heavy bollworm attack.

Similar conditions of high Baraka flow and flooding were recorded in Tokar, giving an effective cotton area of 100,000 feddans. This contrasts with nil returns in the previous season.

The area of private schemes showed an increase of 35,000 feddans,

THE GEZIRA RESEARCH STATION

BY

M. F. ROSE, L. C. HUGHES AND A. LOW.

Survey of the Season.

With the previous season's rainfall of 320 mm. well below the average of 395 mm., and that for the period July 1st-August 15th 34 mm. above the accepted average of 218 mm., yield prospects were most favourable. Excellent yields were eventually returned on the station, establishing an all-time record of 7·73 kantars of seed cotton per feddan (2,324 lb. per acre) and breaking the previous 1950-51 record by 0·78 kantars (234 lb. per acre). The Sakel area (63·4 acres) averaged 6.78 kantars (2,037 lb.) while X1730A (121·7 acres) gave a figure of 8·10 kantars (2,434 lb.). The mean grade of seed cotton from the station was again low—5·32 for Sakel and 5·64 for X1730A—but in the light of lint re-assessment at Port Sudan these figures could well be stepped-up by at least one full grade.

Planting conditions were good, with no untimely rains, and all experimental material was planted between August 14th and 21st. Excellent stands were obtained but heavy weed growth was noted both prior to planting and in the seedling crop. White ant damage was apparent but the attack disappeared in the face of the heavy flooding from September 3rd-14th. On September 3rd, 26 mm. of rain fell on a full irrigation over the miscellaneous breeding plot followed by a further 73 mm. up to the 14th. During this period the field was a swamp. When accessible, it was discovered that a new form of 'systemic' blackarm was devastating all experimental material with the exception of B_2 B_3 B_6 stocks, which showed full immunity. All B_2 B_3 types, to date considered near-immune, were showing full grade 7-8 susceptibility. This was the most disturbing aspect of the whole season*.

No rain was recorded for the second half of September, but sporadic rains fell right through to the end of October: a precipitation of 2·2 mm. on the 25th and 26th was unusually late and assisted in the spread of blackarm. October was relatively cool and pleasant and such conditions prevailed until the end of November. It was noted that from mid-November cotton showed a marked recovery from blackarm attack. December 10th marked a sharp fall in temperature and the true advent of the north wind. From December 25th to January 7th mild conditions were experienced but these were followed by a very cold spell from the 22nd. On January 17th general yellowing was

*In the light of the Shambat Report for 1956-57 further elaboration on this subject is deemed unnecessary.

noted over the whole station and in certain areas there was very rapid boll opening. February temperatures were well down on average and by the 19th effective production on all Sakel types had finished. Temperatures started to rise from the third week in March but by then the whole crop had virtually closed down.

In the light of this record season, four aspects of the crop must be stressed: (1) the absence of premature senescence and leaf shed, (2) the remarkable recovery from the new form of blackarm, (3) the retention of the bottom crop, (4) the very high boll weights.

Jassid and whitefly infestations were light and leafcurl was virtually absent from all experimental plots. Wilt was not recorded on Egyptian varieties although it occurred on American cotton sited on the N.E. extension of the G.R.S. Bollworm was present in the crop, though damage from this pest was not above average. Tree locusts (*Anacridium* spp.) harboured in the crop from the middle of December. They did little damage but similar swarms elsewhere (Abu Habl) reduced cotton populations by 10-15%.

Meteorological data are given below: —

METEOROLOGICAL READINGS, G.R.S., 1956-57.

Date	*Mean Max.* °F.	*Mean Min.* °F.	*Total Rainfall* mm.	*Average Relative Hum.* 8 a.m.
April '56	105 (107)	69 (73)	— (0·3)	16 (20)
May	107 (107)	74 (75)	2·4 (24·2)	25 (33)
June	101 (103)	75 (74)	36·1 (62·0)	51 (50)
July	92 (97)	71 (72)	120·9 (77·2)	76 (76)
August	89 (93)	70 (71)	159·7 (73·1)	83 (73)
September	92 (94)	70 (70)	103·6 (73·5)	79 (76)
October	97 (101)	69 (71)	18·5 (9·3)	59 (55)
November	99 (97)	66 (63)	— (—)	47 (35)
December	92 (92)	58 (55)	— (—)	41 (33)
January '57	89 (89)	54 (53)	— (—)	35 (34)
February	90 (99)	54 (62)	— (—)	32 (35)
March	99 (104)	67 (68)	0·8 (—)	25 (23)
Total			442·0 (319·6)	

Figures in brackets are returns for the 1955-56 season.

BREEDING.

(1) $B_2 B_3$ *Sakel* × $B_2 B_3$ *L Material.*

The object of this programme, already stated in the 1955-56 Report, is three-fold: (1) the production of a $B_2 B_3$ L type equivalent in all respects to the commercial X1730A, (2) the transfer of leafcurl resistance from the L type to BAR 14/25, (3) the creation of a pool of variability by such hybridization.

Ten angias (quarter acre plots), each containing 1 unit of the original cross, were planted on August 14th. The components of each unit are shown below and the future programme indicated.

1956-57	F_2	1st b/c	Recurrent nucleus	1st b/c (recip.)	F_2 (recip.)
1957-58	F_2 (1st b/c)	2nd b/c	Recurrent nucleus	2nd b/c (recip.)	F_2 1st b/c (recip.)
1958-59	F_2 (2nd b/c)	3rd b/c	Recurrent nucleus	3rd b/c (recip.)	F_2 2nd b/c (recip.)

Original crosses:

(BAR 4/16.48 × BAR 14/25) and reciprocal. Recurrent nucleus 48
,, 62 ,, ,, ,, ,, ,, 62
,, 66 ,, ,, ,, ,, ,, 66
,, 106 ,, ,, ,, ,, ,, 106
,, 7 ,, ,, ,, ,, ,, 7

(BAR 4/16 Bk × BAR 14/25 Bk) and reciprocal. Recurrent nucl. BAR 14/25 Bk
BAR 4/16 Bk

(BAR 5/6.24 × BAR 14/25) and reciprocal. Recurrent nucleus 24
,, 39 ,, ,, ,, ,, ,, 39
,, 56 ,, ,, ,, ,, ,, 56

Regarding the production of a B_2 B_3 L type of superior quality, it is considered that segregates from 2nd b/c. material appearing in the breeding plot in 1958-59 should give the desired end point to the backcross programme. However, in the production of a leafcurl resistant Sakel, backcrossing to the recurrent BAR 14/25 will have to be carried well beyond this stage. All segregating material is being tested for leafcurl resistance at Shambat. Four hundred and four single plants have passed the quality filter and will appear in F_3 progeny rows in the coming season.

The programme is an ambitious one and severe discarding will have to be undertaken before this project gets out of hand.

(2) Tanguis × BAR 14/25.

In the past the Sudan has tied itself to the production of the two commercial types, Domains Sakel and X1730A. With vast development schemes under way (an area of $5\frac{1}{2}$ million acres under water is ultimately envisaged) the Sudan may well find itself with a surfeit of the standard varieties and be forced to look to alternative types to satisfy a discriminative demand. The fibre characteristics of Tanguis are not found in any present day variety here and the main object of this work is to combine in one distinct type the whiteness, loofiness, high G.O.T. (36-37%) and high boll weight (3·6 gms.) of Tanguis with the earliness and blackarm resistance of BAR 14/25. This line of work is promising and 35 F_4 lots together with 1st and 2nd b/c. material is being carried forward.

(3) *Contextum Crosses.*

In the light of results from a replicated experiment (see Testing) this line of work has been shelved.

(4) *Strength Transference from Hopi Acala to BAR 7/8.2 and BAR 11/7: Quality Transfer from BAR 11/7 to the Prolific BAR 7/8.2.*

This work, undertaken for the Kadugli Station, is in various stages of progress. As a time-saving measure, seed was utilized from crosses between Hopi Acala, BAR 7/8.2 and BAR 11/7, originally made at Shambat in season 1954-55 for an introgression experiment, and large F_2 populations were sown here during the present season. Following a standard filter, this material was eventually whittled down to 97 single plants. The lint from these together with appropriate controls was sent to the Shirley Institute for stelometer tests. Results have now been received and will form a very useful guide to future selection.

In view of the fact that some backcrossing to the original F_1 plants may have taken place at Shambat, a large scale crossing programme was undertaken and ample F_1 seed (direct and reciprocal) is now available.

Testing.

(1) Two replicated trials of BAR 14/25.4, Groups 1, 2, 3, and BAR 14/25.5, Groups 1, 2, 3, were planted on August 14th. Seed origin was the two cubic lattice experiments of 1954-55 and 1955-56 respectively. Because of big differences in available seed, the two trials were kept separate but in the coming season all 6 lots will appear in the standard variety trials.

	BAR 14/25.4		BAR 14/25.5	
	Lint lb./acre	*G.O.T.*	*Lint lb./acre*	*G.O.T.*
Group 1	863	31·8	923	32·2
2	895	31·5	792	31·2
3	895	31·5	867	31·5
BAR 14/25 Bk ...	837	31·3	886	30·4
S.E. (Mean)	20		46	
Sign. diff.	Non-significant		Non-significant	
	10 replications		5 replications	

Although neither result is significant, the average yield figure for the groups of BAR 14/25.4 shows approximately the same increase of lint (5·6%) over control as was noted in the 1955-56 season. That a significant advance is being made is shown by the yield contrast of parental bulk and BAR 14/25.4 in the standard trials at the G.R.S. and Hag Abdulla. In view of the fact that BAR 14/25.5 was selected from BAR 14/25 parental bulk and not from BAR 14/25.3 a lint increase of 4·2% (Group 1 over control) is disappointing.

(2) In order to assess the value of the 8 nuclei appearing as recurrent parents in the B_2 B_3 S × B_2 B_3 L crossing programme, a randomized block experiment of 6 replications was laid down on August 14th. X1730A, BAR XL1 and BAR 4/16 were included as controls. The origin of these 8 nuclei dates back to the 1953-54 season when they appeared as the highest yielders in 2 factorial experiments following the 'Breeding Phase' of BAR 4/16 and BAR 5/6. It should be noted that selection for high ovule number per loc was one of the criteria in the 1952-53 season. On bulking according to yield and followed by 2 years general panmixis, these 8 lots gave rise to the 3 groups listed under BAR 4/16 and BAR 5/6 which now appear for the first time in the standard variety trials. Concurrently the individual nuclei have been carried on as such over the years. Yield figures are shown below: —

Strain	*Lint lb./acre*		*G.O.T.*
BAR 4/16 48	968		33·5
,, ,, 62	1049		34·0
,, ,, 106	915	M = 941	33·7
,, ,, 7	899		31·9
,, ,, 66	878		33·3
BAR 5/6 24	880		33·0
,, ,, 56	882	M = 879	32·7
,, ,, 39	876		34·0
BAR 4/16 Bk	966		33·3
X1730A	1077		36·2
BAR XL1	996		35·8
S.E. (Mean)	44		—
Sign. diff. (P=0·05)	132		—

These yield figures reflect the trend shown in the original factorial experiments, with X1730A top, BAR 5/6 bottom and BAR 4/16 intermediate: only 2 substrains, BAR 4/16.48 and BAR 4/16.62, approach X1730A in yield while none is significantly better than BAR 4/16 Bk. From the single spinning test available there is little to choose between the 8 lots. All are inferior in quality to X1730A control. A survey of all yield data from the present season indicates that BAR 5/6 is consistently down on BAR 4/16. In consequence all hybrid material containing BAR 5/6 will be discarded from breeding stocks.

(3) Eleven lots of B_2 B_3 B_6 seed (L origin) were sent from Shambat to Medani for testing. Owing to the extreme variation in the quantity of seed supplied, it was decided to plant 2 trials, one a very small scale trial (1 row plots) to include all material, and a small scale trial of 3

row plots where adequate seed was available. The yields from the 2 trials are combined in the table below: —

	Very small scale trial		*Small scale trial*	
	Lint lb./acre	*G.O.T.*	*Lint lb./acre*	*G.O.T.*
X1730A	1152	36·1	1105	35·8
BAR 4/16	970	33·3	956	32·8
BAR 4/24	731	30·6	679	31·4
BAR 4/25 A	562	30·3	—	—
,, ,, B	632	29·9	—	—
,, ,, C	970	32·6	979	31·8
,, ,, D	1138	32·3	1218	32·2
,, ,, E	970	31·7	—	—
,, ,, F	857	32·0	—	—
,, ,, G	941	31·9	904	32·4
,, ,, H	1068	33·5	885	31·8
BAR 5/6	913	32·8	820	32·7
BAR 5/7 A	857	30·2	—	—
,, ,, D	688	30·3	815	31·3
,, ,, E	956	30·9	778	30·5
S.E. (Mean)	82		132	
Sign. diff. (P=0·05)	238		N.S.	

These yield figures are most encouraging and indicate a variability never found in B_2 B_3 L material. With the exception of BAR 4/25 H, which was segregating for blackarm resistance, all sub-strains showed complete immunity to systemic attack.

(4a) Five lots of hairy Sakels carrying B_2 and B_3, but not homozygous for these factors, were planted in a replicated (6) trial on August 15th. All lots together with the controls Domains Sakel and BAR 14/25 were devastated by the new form of blackarm and at one stage the trial was abandoned. A striking recovery was noted on all strains from November 21st, and Domains Sakel returned the phenomenal yield of 911 lb. of lint per acre.

	Lint lb./acre	*G.O.T.*
BAJ 1/56	564	29·7
,, 2/56	474	30·1
,, 3/56	485	31·5
,, 4/56	548	31·4
,, 5/56	453	33·6
BAR 14/25	890	31·0
DS	911	32·1
S.E. (Mean)	63	
Sign. diff. (P=0·05)	187	

The yields from all BAJ lots are significantly lower than those of DS and BAR 14/25 while the Chief Cotton Examiner's assessment of lint shows marked down-grading of all hairy types (DS and BAR

14/25, Grade 1. BAJ's, Grade X5 to 5). From past experience it would appear that the gene H_1 plus its modifier complex on a *barbadense* background so reduces yield and grade that straightforward selection within such hybrid material cannot hope to bridge the gap between such strains and commercial requirements. In consequence the bias will swing from H_1 to H_3 (modified hairiness) in all future jassid resistance work.

(4b) Two lots of hairy Wilds SUS 16/1 ex Shambat together with parental bulk as a control were planted in a replicated (12) trial on August 15th. Adjacent to the hairy Sakels, the 3 lots suffered very severely from blackarm attack and like them made a remarkable recovery. This is the first recorded instance of blackarm attack on Wilds SUS 16/1 under field conditions. Yield figures are shown below together with the Chief Cotton Examiner's remarks on lint.

	Lint lb./acre	*G.O.T.*	*Colour*	*Staple*	*Comments*
BAJ 6/56	717	34·0	Good	$1\frac{1}{4}''$	Av. strength
,, 7/56	633	33·0	,,	$1\frac{1}{8}''$	,, ,,
Wilds SUS 16/1 (Control)	760	33·6	,,	$1\frac{5}{16}''$	Nice ,,
S.E. (Mean)	26				
Sign. diff. (P=0·05)	75				

Here again it would appear that transfer to the *hirsutum* background has reduced yield and quality but the divergence from control is not so marked as in the hairy Sakels.

(5) 4 loc Sakels (4 lots) and high ovule number Sakels (9 lots) were sown in separate replicated trials on August 15th. Yields and details of the seed and boll analysis have been passed to Shambat for inclusion in their Report. The high ovule transfer material has yielded valuable lines for future selection: regarding the 4 loc Egyptians, the transfer of this character from *hirsutum* has most certainly been effected but the defect of non-viable seed (noted over consecutive years) must be eliminated before any future advance can be anticipated.

(6) Since 1951 much time and attention has been devoted to the transfer of partial lint retention from *G. contextum* and 'Stormmaster' to Sakel types. In the light of more pressing demands, it was deemed advisable to take stock of the situation and see what advance had been made in this line of work. Ten 'stormproof' types (3rd b/c. F_2's) were included in a replicated (4) trial and a detailed study was made

of the lint retention complex from boll opening. The yield figures shown below are disappointing. All lots are significantly worse than control, with quality mediocre: detailed examination in the field indicated a weak retention, of a degree which could probably be obtained more expeditiously by straightforward selection within Sakel itself. In consequence this project has been dropped.

	Stormproof Types.	
	lb. lint/acre	*G.O.T.*
F33	646	28·2
F34	768	29·7
F35	638	28·3
F36	591	27·9
F37	799	28·2
F38	688	28·8
F39	592	27·3
F40	618	26·9
F41	598	27·7
F42	567	27·0
BAR 14/25	923	30·6
S.E. (Mean)	41	
Sig. diff. (P=0·05)	118	

(7) At the request of the Sudan Gezira Board, BLR 14/16 (B_2 Sakel) was brought back into small scale propagation. It will be remembered that this type was dropped from the standard variety trials in 1951-52 on the grounds that its quality was outside the Sakel range. To obtain further data on its relative merits, BLR 14/16 was grown with BAR 14/25 in a small scale trial of 14 replications. The final yields were: BLR 14/16, 624 lb. of lint per acre, G.O.T. 29·6: BAR 14/25, 672 lb., G.O.T. 31·2: the mean difference was not significant. These returns are according to expectation but the G.O.T. of BLR 14/16 is high.

Standard Variety Trials.

The standard variety trials were planted at Turabi (North) Gezira Research Station (Centre) and Hag Abdulla (South) on the 14th, 18th and 17th August respectively: layout and general practice were the same as in past years. Establishment and initial stands were good and the cotton received no check until the advent of blackarm, approximately one month after planting. This occurred at all 3 sites with increasing intensity from North to South, a circumstance possibly determined by rainfall.

At Turabi, counts on the 17-18th November indicated an infection of 91% on Domains Sakel and 4·5% on Sakel derivatives. In both cases full grade '8' leaf infection was recorded, indicating a marked shift towards susceptibility of B_2 B_3 material. The new stem phase was not apparent. Jassid attack was heavy throughout the trial with whitefly light: slight leafcurl was noted on all Sakel types. All yields

were well above average. Lint returns from Sakel derivatives (B_2 B_3 types) were down on Sakel itself while trends within the L group were according to expectation. X1730A again showed a lint superiority over BAR XL1 of 5%.

At the Gezira Research Station, whitefly and jassid were virtually absent from the trial. Blackarm, however, was sporadic in attack and all varieties showed both stem and leaf lesions (grade 8). From 21st November all plants appeared to grow away from the disease. Average yields were of a high order. The response of BAR 14/25.4, outyielding its parent BAR 14/25 by 111 lb. lint, was gratifying. There was little to choose between X1730A, BAR XL1 and BAR XL3, while BAR 4/16 and BAR 5/6 were down on lint returns. The yields from the groups derived from parental bulks BAR 4/16 and BAR 5/6 (for origin see Breeding) reflect roughly the yields given by previous small scale trials. The advance, however, is not spectacular. BAR 4/16 Bk has outyielded BAR 5/6 Bk by 48 lb. of lint per acre, an increase confirmed by previous yield data.

At Hag Abdulla, severe blackarm ran riot through the trial and when this was inspected in early November very low final yields were anticipated. The trial experienced severe waterlogging when 70 mm. of rain in October fell on a full irrigation and this doubtless increased the virulence of the initial attack. All plots and all varieties showed severe infection (both leaf and stem) and no semblance of resistance could be found. From the end of November, however, recovery was apparent and phenomenal yields were eventually returned. Domains Sakel, which normally would have been wiped out, gave 2,641 lb. of seed cotton per acre, an all-time record for the Southern trial. In the light of the present season's figures, it is apparent that the old ideas on the disease/plant relationship in terms of yield must be profoundly revised. For the second year in succession the yields of Sakel and Sakel derivatives have been very high and phenomenal yields have again been given by Sakel on the Barakat Seed Farm. This is a reversal of the generally accepted order and contrary to past experience. It may well be that subtle changes are taking place in the climatic regime of the South, favouring the Sakel genotype.

With a yield of lint per acre of 943 lb. (3,013 lb./acre s/c) BAR 14/25.4 has outyielded BAR 14/25 and Domains Sakel by 43 and 98 lb. respectively. BAR XL1 has shown a lint superiority over X1730A of 11% while the relative positions of BAR 4/16 Bk and BAR 5/6 remain the same. It should be noted, however, that the margin between the two strains has been considerably reduced in the Southern trial.

Relevant data for the three trials are shown in Table 1, while Tables 2 and 3 give a summarized performance of yield and spinning values.

Table 1.

Gezira Variety Trials, 1956-57.

Yields of Seed Cotton and Lint in pounds per acre.

Variety	Bar Genes	Turabi (North)			G.R.S. (Centre)			Hag Abdulla (South)			Overall Means		
		Seed Cotton	Lint	G.O.T.	Seed Cotton	Lint	G.O.T.	Seed Cotton	Lint	G.O.T.	Seed Cotton	Lint	G.O.T.
S GROUP													
Domains Sakel	—	1717	534	31·1	2487	791	31·8	2641	845	32·0	2282	723	31·6
BAR 14/25	B_2 B_3	1754	507	28·9	2328	729	31·3	2886	900	31·2	2323	712	30·5
BAR 14/25.4	B_2 B_3	1750	511	29·2	2666	840	31·5	3013	943	31·3	2476	765	30·7
L GROUP													
X1730A	—	1890	646	34·2	2674	955	35·7	2648	943	35·6	2404	848	35·2
BAR XL1	B_2	1832	617	33·7	2641	943	35·7	2796	1046	37·4	2423	869	35·6
BAR XL3	B_2	1875	626	33·4	2633	932	35·4	2732	973	35·6	2413	844	34·8
BAR 4/16 Bulk	B_2 B_3				2690	901	33·5	2565	854	33·3	2627	877	33·4
BAR 4/16 Group 1	B_2 B_3				2704	919	34·0	2661	897	33·7	2683	903	33·9
,, ,, 2	B_2 B_3				2695	916	34·0	2558	865	33·8	2626	890	33·9
,, ,, 3	B_2 B_3				2572	872	33·9	2637	889	33·7	2605	880	33·8
BAR 5/6 Bulk	B_2 B_3				2548	853	33·5	2522	845	33·5	2535	849	33·5
,, ,, Group 1	B_2 B_3				2673	903	33·8	2549	861	33·8	2611	882	33·8
,, ,, 2	B_2 B_3				2623	886	33·8	2490	832	33·4	2556	859	33·6
,, ,, 3	B_2 B_3				2599	878	33·8	2328	775	33·3	2463	826	33·6
Standard Error (Mean)			10			24			24				
Sign. Diff. (P=0·05)			28			68			67				

TABLE 2.

SUMMARY OF PERFORMANCE OF CURRENT STRAINS IN GEZIRA VARIETY TRIALS UP TO AND INCLUDING SEASON 1956-57.

Variety	Basic Type	Seed Cotton (lb./acre)						Lint (lb./acre)						Location
		No. of Trials	Mean			Variety as % of		No. of Trials	Mean			Variety as % of		
			Variety	X1730A	Dom. Sakel	X1730A	Dom. Sakel		Variety	X1730A	Dom. Sakel	X1730A	Dom. Sakel	
Dom. Sakel	—	18	1300	1324	1300	98	100	18	417	474	417	88	100	Northern Gezira
BAR 14/25	B_2 B_3	7	1562	1578	1553	99	101	7	488	565	505	86	97	
BAR 14/25.4	B_2 B_3	1	1750	1890	1717	92	102	1	511	646	534	79	96	
X1730A	—	18	1324	1324	1300	100	102	18	474	474	417	100	114	
BAR XL1	B_2	14	1368	1422	1389	96	98	14	486	507	450	96	108	
BAR XL3	B_2	5	1655	1642	1586	101	104	5	576	578	510	100	113	
Dom. Sakel	—	31	1514	1773	1514	85	100	31	480	626	480	77	100	Central Gezira
BAR 14/25	B_2 B_3	7	1658	1687	1478	98	112	7	523	607	480	86	109	
BAR 14/25.4	B_2 B_3	1	2666	2674	2487	100	107	1	840	955	791	88	106	
X1730A	—	31	1773	1773	1514	100	117	31	626	626	480	100	130	
BAR XL1	B_2	15	1701	1606	1354	106	126	15	604	577	437	105	138	
BAR XL3	B_2	5	1863	1753	1495	106	125	5	658	626	485	105	136	
BAR 4/16 Bulk	B_2 B_3	1	2690	2674	2487	101	108	1	901	955	791	94	114	
,, ,, Group 1	,,	1	2704	2674	2487	101	109	1	919	955	791	96	116	
,, ,, ,, 2	,,	1	2695	2674	2487	101	108	1	916	955	791	96	116	
,, ,, ,, 3	,,	1	2572	2674	2487	96	103	1	872	955	791	91	110	
BAR 5/6 Bulk	,,	1	2548	2674	2487	95	102	1	853	955	791	89	108	
,, ,, Group 1	,,	1	2673	2674	2487	100	107	1	903	955	791	95	114	
,, ,, ,, 2	,,	1	2623	2674	2487	98	105	1	886	955	791	93	112	
,, ,, ,, 3	,,	1	2599	2674	2487	97	104	1	878	955	791	92	111	
Dom. Sakel	—	14	1443	1596	1443	90	100	14	460	565	460	81	100	Southern Gezira
BAR 14/25	B_2 B_3	7	1541	1588	1413	97	109	7	472	560	447	84	106	
BAR 14/25.4	B_2 B_3	1	3013	2648	2641	114	114	1	943	943	845	100	112	
X1730A	—	14	1596	1596	1443	100	111	14	565	565	460	100	123	
BAR XL1	B_2	14	1539	1436	1239	107	124	14	543	506	397	107	137	
BAR XL3	B_2	5	1859	1769	1557	105	119	5	651	624	492	104	132	
BAR 4/16 Bulk	B_2 B_3	1	2565	2648	2641	97	97	1	854	943	845	91	101	
,, ,, Group 1	,,	1	2661	2648	2641	100	101	1	897	943	845	95	106	
,, ,, ,, 2	,,	1	2558	2648	2641	97	97	1	865	943	845	92	102	
,, ,, ,, 3	,,	1	2637	2648	2641	100	100	1	889	943	845	94	105	
BAR 5/6 Bulk	,,	1	2522	2648	2641	95	95	1	845	943	845	90	100	
,, ,, Group 1	,,	1	2549	2648	2641	96	96	1	861	943	845	91	102	
,, ,, ,, 2	,,	1	2490	2648	2641	94	94	1	832	943	845	88	98	
,, ,, ,, 3	,,	1	2328	2648	2641	88	88	1	775	943	845	82	92	

TABLE 3.

SUMMARY OF SPINNING TEST REPORTS ON CURRENT STRAINS IN GEZIRA VARIETY TESTS, 1942-43 TO 1955-56.

Variety	*Type*	*Effective Length 32's*			*Standard Hair Weight*			*Corrected Lea-Strength Products.*					
			Means			*Means*			*Means of 80's Counts*			*Means of 100's Counts*	
		No. of Trials	*Variety*	*Dom. Sakel*	*No. of Trials*	*Variety*	*Dom. Sakel*	*No. of Trials*	*Variety*	*Dom. Sakel*	*No. of Trials*	*Variety*	*Dom. Sakel*
BLR 14/16	B_2	4	49·2	46·8	4	141	148	4	2617	2571	4	2377	2261
BAR 14/25	B_2 B_3	15	48·0	46·0	15	147	148	15	2519	2523	15	2233	2214
		No. of Trials	*Variety*	*X1730A*	*No. of Trials*	*Variety*	*X1730A*	*No. of Trials*	*Variety*	*X1730A*	*No. of Trials*	*Variety*	*X1730A*
BAR 1730L–1	B_2	29	47	46	29	163	163	37	2068	2065	28	1801	1825
BAR 1730L–3	B_2	12	46	46	12	164	162	12	2185	2165	12	1814	1860

Miscellaneous Testing.

In past years the Zeidab Estates have shown a marked preference for the variety Coker Wilds grown as a single strain throughout the whole area. In the 1956 season, however, this variety was dropped and followed by a large scale importation of Coker Wilt 100 seed from America. Some doubt was entertained as to the wisdom of this change-over and at the request of the Department of Agriculture a variety trial was laid down at Aliab in Northern Province. Unfortunately no seed of Coker Wilds was available and in consequence Wilds SUS 16/1, derived directly from it, was substituted as control. The early, very prolific Punjab 268F was included together with Hopi Acala. The trial, of 14 replications and plot size 0·029 acres, was planted on 21st May. Picking was from 13th September to 17th November.

	S/c. lb./acre	*Lint lb./acre*	*G.O.T.*
Punjab 268F	1239	424	34·2
Coker Wilt 100	1111	390	35·1
Wilds SUS 16/1	979	301	30·7
Hopi Acala	681	207	30·4
S.E. (Mean)		17	
Sign. diff. (P=0·05)		48	

Although Coker Wilt 100 showed a marked superiority in lint yield over control, its staple length and grade generally were down. Spinning test figures are not yet available but it would appear that a trade preference for the old quality will induce the Estates to revert to Coker Wilds.

Miscellaneous.

Grade.

The fall in average grade of the two commercial varieties Domains Sakel and X1730A has been a matter of concern to this Section. It is apparent from spinning test data together with average grade figures supplied by the commercial graders that quality has deteriorated since 1946. Although yearly fluctuations (from spinning test data) are marked, it must be admitted that a definite downward trend is in evidence. The questions of the effect of environment and the possibility of genetic breakdown, or both, have been reviewed elsewhere*.

The Aden crop (X1730A) has in the past been giving good average grade and since the seed origin was the Sudan (1951) it was considered that some light might be thrown on the question of environment by bringing Aden seed back to the Sudan for direct comparison with Gash

*Rose, M. F. and Hughes, L. C. Miscellaneous Publication G.R.S. No. 81. Hughes, L. C. Miscellaneous Publication G.R.S. No. 81 (a).

seed. Through the courtesy of the Abyan Board, X1730A seed was supplied direct to this Section and 5 acres were planted alongside 5 acres of Gash seed. Planting dates and cultural operations were similar. As it was impossible to handle the seed cotton from the whole of the 10 acres, each field was sampled by taking one angia ($\frac{1}{4}$ acre) from the north, centre and south for direct comparison. All seed cotton from these 6 angias were graded by picks and later lint samples were sent to Port Sudan for further assessment. Grade figures are shown below: —

	Seed Cotton : Mean Grade over all sites.	
	Gash Seed	*Aden Seed*
Pick 1	3·5	3·7
2	3·9	4·3
3	5·0	5·0
4	7·0	7·0
5	8·0	7·3
6	—	8·0

	Seed Cotton : Mean Grade over all picks.	
	Gash Seed	*Aden Seed*
North	4·3	5·7
Centre	5·3	5·6
South	5·6	5·6
Overall Mean grade	5·1	5·7

Lint Grade (Port Sudan).

Seed cotton	*Gash Seed*	*Aden Seed*
4 (ex Medani)	4 colour : X3/3 staple	2 colour : 2 staple
5 (,,)	5 ,, : 5 ,,	X4 ,, : X4 ,,
X6 (,,)	5 ,, : 5 ,,	X5 ,, : X5 ,,
7 (,,)	6 ,, : 6/7 ,,	X6 ,, : X6 ,,

Commercial Crop X1730A.

Average Grade Seed Cotton.

	1952-53	1953-54	1954-55	1955-56
Aden	2·4	2·6	4·1	3·8
Gezira	5·86	5·59	5·09	5·59

Mean grades in terms of seed cotton and lint are conflicting. Seed cotton grading favours Gash seed while lint grading of a parallel series of identical grades of seed cotton favours Aden seed. Even if the lint figures from Port Sudan are accepted as the more reliable criterion, the divergence between Aden and Gash seed is not nearly so striking as mean grade differences in the two commercial crops from 1952 to 1955.

It would appear that environment is playing some part in this deterioration and it must be admitted that the practice of spraying and manuring over ever-increasing areas is a potent factor in promoting environmental change.

In order to have some measure of the rate of deterioration, that is assuming genetic breakdown is taking place, 5 lots of old seed, X1730A 48/49, DS1 DS2 DS3 48/49, DS 48/49, X1530 47/48 and X1730A 47/48, were brought to light. These, together with new seed of DS and X1730A (1955-56) were planted in a replicated (3) trial over two angias. Unfortunately viability of seed was very low and an average emergence of 0·5% was recorded over all old lots. In consequence all available plants (including DS and X1730A 1955-56) were selfed and this seed will be used in a 'repeat' experiment in the coming season.

Salt Tolerance.

In the absence of temperature and humidity control, floor space and time, this line of work has presented difficulties from its inception. It was considered that an assessment of any advance should be made at this stage and salt-tolerant BAR 14/25 be tested against parental control. The history of the salt tolerant seed is as follows:

1952-53—1st salt filter followed by planting-out and natural panmixis.
1953-54—2nd salt filter followed by planting-out and natural panmixis.
1954-55—3rd salt filter followed by planting out and brush panmixis.
1955-56—4th salt filter followed by planting-out and brush panmixis.

Using the standard pot and saucer technique, 18 replications of each variety were planted with 100 sound seeds to each replication. The emergence percentage was as follows: salt tolerant BAR 14/25—20·1%: BAR 14/25 control—17·4%, with mean difference non-significant. In the light of more pressing commitments this work has been shelved. However, in the absence of effective natural cross pollination and only 2 years of brush panmixis it might well be argued that this work has not been pushed far enough.

PROPAGATION.

The following areas were under the direct supervision of the Cotton Breeding Section.

Blue Nile Province:—

1. Guneid: BAR XL1, 70 acres (RR) nucleus rogued area.
2. Feragin: BAR 14/25, 25 acres (RR) nucleus rogued area.
3. Abu Guta Seed Farm: BAR 14/25.4, Group 1.2.3. and BAR 14/25.5, Group 1.2.3, 2 acres: expansion phase for standard variety trials.
4. Abu Guta Prison Farm: BAR 11/7, 2 acres: general multiplication.

Kassala Province:—

1. Tokar: XAT1 and XAT, 80 acres of XAT1 belted by 400 acres XAT. 'Acclimatization' policy.

Northern Province:—

1. Shendi: Wilds SUS 16/1, 30 acres (RR) nucleus area.
2. Zeidab: Coker Wilt, 10 acres (RR) nucleus rogued area.

Kordofan:—

1. Abu Habl: BAR 7/8.1, 30 acres (RR) nucleus rogued area.

Publications.

Low, A. Darfur 1956—Some Impressions. Empire Cotton Growing Review. Vol. XXXIV, No. 1. January 1957.

SHAMBAT STATION

BY

S. O. S. DARK AND J. H. SAUNDERS.

Meteorology.

Rain started towards the end of June and continued with regularly spaced showers until the beginning of October. The total rainfall for the season was 9·7 ins.

The winter was the longest and coolest within living memory. The monthly mean maximum temperature ranged from 105·8°F in May 1956 to 84·2°F in January 1957 with a mean maximum of 95°F for the year.

Blackarm.

The season 1956-57 showed a very definite change in the blackarm situation in the Sudan.

Field Observations.

In the Gezira some concern had been felt in the preceding year because Sakel and L cottons bearing $B_2 B_3$ genes were showing in the field some angular leaf spot grade 7-8 which had never previously been observed. A search of the Shambat records showed that the grade of BAR 14/25 had slipped from mean 3·7 in 1951 to 5·7 in 1953 and 5·4 in 1956. This is probably the result of adaptation of the bacterium to the host plant. It is not a loss of resistance, because the lowest grade recorded is '7' and no susceptible plants have appeared. This also rules out the possibility of the stocks being heterozygous for $B_2 B_3$ genes.

In 1956-57, however, blackarm was widespread in all varieties in G.R.S. breeding plots, and in V.T.'s at G.R.S. and Hag Abdulla. At the height of the attack it was impossible to distinguish between B_2 B_3 resistance and full susceptibility in these plots. Vein and stem lesions were also present in all varieties. Wilds SUS 16 which although fully susceptible when sprayed at Shambat has never been recorded with blackarm under field conditions, was this year heavily infected. Although blackarm was very serious on all these plots it is reported as negligible on the rest of the G.R.S. and in the Gezira commercial crop as a whole.

By November 20th, there were no angular leaf spots remaining, but the veins with the adjacent tissue were showing the attack and wet patches were still developing. The symptoms appeared to have developed very regularly on the leaves from the base of the plants upwards and outwards. From this time onwards however there seemed to be no new spread of the symptoms—merely the patches on leaves already attacked continued to extend a little in length.

The plants, however, despite the initial heavy attack, recovered rapidly and eventually bore a good crop.

The heavy over-riding attack seems to have been due to the water logging conditions brought on by the coincidence of a very heavy late rainstorm with an irrigation.

In Shambat there was a heavy natural infestation in addition to the spraying done for grading purposes.

By the first week in November there was practically no angular leaf spot on the farm, all the leaves having fallen which bore this attack. However every variety, except those bearing the factor B_6, showed vascular lesions on the mid plant leaves, the tissues adjacent to the veins still showing wet patches. The bracteoles, the bases of the bolls and in some cases the boll walls as well, all bore wet lesions. Sometimes the infection had worked through the basal boll tissue and invaded the lint and seeds. A few cases were found of blisters on the petioles filled with bacterial slime. This late attack appeared not to incommode the plants. In some leaves whole sections died through bacterial action blocking a major vein and thus cutting off the water supply, but generally the lesions appeared to extend slowly along the margins of the affected veins and then dry off without causing much damage.

A similar sequence followed in the out-of-season crop. The spraying inoculation took nearly 3 weeks to establish angular leaf spot lesions and when these leaves had fallen, the leaf vascular lesions, bracteole and boll pedicel lesions persisted and were still wet in May. Stem lesions were few in number and apparently insignificant in effect.

Agronomic Significance of the Manifestations.

The vascular lesion on leaves in the Gezira might just possibly have arisen from rain spread infection, but at Shambat symptoms characteristic of the new form of the disease appeared and developed after the rains had ceased. Hence the outbreak must have been due either to systemic infection, i.e. the bacterium was carried inside the plant and developed in various places, or to the disease being spread by an insect vector. The apparently ordered progression of the symptoms upwards through the plants is a strong argument against carriage by insects.

If we accept the hypothesis of systemic attack, what are the implications? Our experience so far would indicate that such a late attack has little effect upon the cropping of the plants. However the presence of the active bacterium in tissues so late in the season would indicate that the amount of infective debris at the end of the season could be very considerable, so that the necessity for an efficient "clean-up" after the crop is further emphasized. Of greater potential importance is the circumstance that if the bacterium can travel inside the plant, there seems to be nothing to prevent it from entering a small percentage of the seeds via the attachment of the ovule to the placenta. If this happened, no seed surface sterilization system would eliminate primary plant infections. According to Uganda opinion this type of infection does not occur, but it is perhaps significant that laboratory tests at Medani of efficiently surface sterilized seeds have always given a very small percentage of seedlings with primary infection, when germinated under sterile conditions.

Experimental Observations.

Dr. Sabit, working on the histological aspects of the resistance conferred by the B genes transferred to Sakel cotton, made the following observations last year. The bacterium attacked the leaves of susceptible varieties by destroying large patches of parenchyma tissue, which was replaced by clumps of bacterial slime. These patches were bounded by the minor leaf veins which were not attacked. In all the varieties bearing B resistance factors, the bacterial slime masses were circumscribed within single host cells, or small groups of them. However those circumscribed masses put out hyphal-like extensions of bacterial slime which worked through or between the host cells until they reached a major leaf vein, when the xylem tissue was invaded by the bacterium which entered the vessels. This occurred in all cases except when B_6 was present as a resistance factor. In this case it was found that the bacterial slime masses were circumscribed, but did not put out the processes so that no vascular infection was seen.

Dr. Last, using a technique of inoculating young plants by injecting cultures of the bacterium into the stem from a needle, has demonstrated

that the bacterium when inoculated at one site will travel through the plant and produce lesions at other places, and can be recovered from these lesions. The degree of attack and amount of movement are correlated with the age of the plant when inoculation is performed and the site of inoculation in relation to the place where growth is occuring at the time. When the bacterium is put inside the stem in this way, the B genes (with the exception of B_6) are of no avail—even B_6 will not prevent a slight systemic infection in these circumstances.

At Shambat the upper parts of 7 $B_2 B_3$ plants and 7 Sakel plants were protected from blackarm spraying by polythene bags. The following day the bags were removed when there could be no possibility of wet inoculum contaminating the protected leaves. A month later each of two of the Sakel plants had developed vein lesions on one of its protected leaves.

Causes of the Change.

The possible causes of the change in blackarm attack seem to be the following:

I. Environmental change:
   (a) External: Climatic conditions—particularly humidity.
   (b) Internal: Resistant plant phenotype forces the bacterium into new types of attack expressed as new symptoms, i.e. the plant-bacterium interaction has changed.

II. The bacterium has altered:
   (a) New form of *X. malvacearum* introduced from abroad (possibility mentioned by Knight, 1946: Emp. Jour. Exp. Agric., p. 154).
   (b) A new mutation has just arisen.
   (c) An old mutation has been filtered out from a mixed bacterial population and built up by the action of resistant cotton varieties.

III. The cotton plants have changed:
   (a) By a back-mutation of the B_3 resistance genes to susceptibility.
   (b) By loss of some other portions of the genotype which are necessary to interact with B genes to give high grade resistance.

Conclusion.

There seems no doubt that the special symptoms of the blackarm attack this season were due to the unusual weather conditions producing water logging of the plants. Whether there has been any alteration in the bacterium cannot be stated. The description by Knight and Clouston (Jour. Gen., 1939, 38, pp. 137-8) would indicate that systemic infection has always been present in resistant plants, and it may be

that systemic infection is normally widespread but only develops symptoms under special environmental conditions, such as occurred this year.

Genetics.

Production of Egyptian Varieties Resistant to Blackarm.

Because of the inadequacy of the $B_2 B_3$ blackarm resistance under the conditions which developed this year in the Gezira, it has become of first importance to introduce the B_6 resistance factor. BAR 14/48 ($B_2 B_3 B_6$) has been produced and passed to Medani for preliminary testing next year. It is a 6th backcross to Sakel but only 2nd b/c. to BAR 14/25 type. Strains to follow it have already reached the 5th b/c. to BAR 14/25 type.

BAR 4/25 ($B_2 B_3 B_6$) and BAR 5/7 ($B_2 B_3 B_6$) are the most advanced strains of L cotton carrying all three factors (being 6th b/c. to X1730 type). These varieties only differ in that the latter carries the red flagging gene R_2^{RS}. They have been sent to Medani for preliminary testing and propagation.

Other Transferences of Blackarm Resistance.

The transferences of $B_2 B_3$, $B_2 B_6$ and $B_2 B_3 B_6$ to Karnak, Pima S_1 and Acala 4-4-2 are proceeding.

Another transference of $B_2 B_6$ to BP52 has been completed.

The synthesis of $B_2 B_6$ and $B_2 B_3 B_6$ strains of the American Upland types derived from PSS, SP84 and Wilds SUS 16 is proceeding.

Investigation is continuing of the blackarm resistance factors transferred from *herbaceum* to Sakel.

Jassid Resistance.

This year's work on jassid resistance has been confined to obtaining lines homozygous for $B_2 B_3$. This has been a necessary phase in the work since jassid resistance without blackarm resistance for the Gezira would be unacceptable.

18 families homozygous for H_1 or $H_1 H_3$ selected over a number of generations for hair density and length were grown. These were sprayed with blackarm inoculum and graded. All plants showing less resistance than the control type BAR 14/25.3 ($B_2 B_3$) were removed. The remainder were individually selfed. These provided 324 progenies in the out-of-season planting and they in turn were sprayed with blackarm inoculum and graded. 92 progenies were considered to be homozygous for $B_2 B_3$. A check will be made upon these families in the coming season.

Although most of the lines show very good hair densities the length is as yet somewhat short. The genetic background of *G. barbadense*

appears to have a shortening effect upon hair of good length transferred from other types. Indications in other work on hairiness suggest that this difficulty may be overcome and that length genes of major effect exist.

Studies on the genetics of hairiness continue.

Yield.

At Medani 3 families of the 7th b/c. transference of the 4 loc character from *hirsutum* cotton to $B_2 B_3$ Sakel were tested for yield and seed qualities. The multiloc character was satisfactory –mean value 3·8 locs per boll—but there seems to be also a sterility factor present. This will be investigated next season because so far no sterility has been observed in similar families at Shambat.

Further backcrosses and transferences of the character to S and L cottons bearing $B_2 B_3 B_6$ blackarm resistance were carried out this season.

The segregating families that were scored this year did not contradict the postulate (last season's report, p. 15-16) that a major key gene is acting in conjunction with a polygenic system for increasing the loc number per boll. A series of test crosses was made this season which should provide a definite answer next year.

Nine blackarm resistant high ovule number families were tested at Medani this year and four of these (BAN 1, 4, 6, 7) were found to yield better than Sakel controls. Two lines, BAN 6 and BAN 7, were better than anything else and were 10% better than the control type for yield. In general, quality was inferior and lint length somewhat shorter. However, as yet no selection has been practised for these characters. The first requirement was the proof that increase of ovule

BAN TYPES, 1956-57.

	S/c lb./acre	*Lint* lb./acre	*G.O.T.*	*Boll wt.*	*Lint index*	*Seed wt.*	*Seeds per boll*	*Ovules per boll*	*Motes %*	*Mean max mms.*
BAN 1	2284	738	32·4	3·37	5·3	11·1	20·5	21·7	5·5	45
2	2009	618	31·0	3·10	5·1	11·2	18·8	19·8	5·7	47
3	2061	635	31·4	3·23	5·2	11·3	19·4	19·9	4·7	46
4	2249	721	32·6	3·35	5·3	10·8	20·7	21·8	4·7	44
5	2146	687	32·2	3·24	5·4	11·2	19·3	20·3	5·2	46
6	2456	756	31·5	3·15	5·5	11·7	18·2	18·9	4·9	45
7	2301	756	34·0	3·45	5·8	11·3	20·2	21·2	4·9	44
8	1958	601	30·8	3·30	5·4	12·1	18·9	19·6	5·6	46
9	1666	515	31·3	3·16	5·4	11·8	18·2	19·2	5·3	46
DS 14/25	2215	687	31·8	3·17	5·6	11·9	17·9	18·8	4·8	47
	2198	670	31·9	2·90	5·3	11·3	17·1	18·2	5·3	46
C.V.	14·8	14·8	2·1	4·2	2·8	3·4	2·4	2·6	13·7	3·6
Sig. diff. (P = ·01)	412	132	0·9	0·18	0·2	0·5	0·6	0·9	N.S.	N.S.

number could enable increases in yield to be obtained. It would appear from these results that this is the case and that this line of work would be profitable in the future.

Twenty-five families were grown at Shambat and subjected to single plant selection on the basis of ovule number. Of these 163 were finally grouped into 18 bulks according to ovule number level taking into account breeding history, i.e. 3rd backcrosses were not bulked with 4th backcrosses and so on. These were sown out-of-season and brush panmixed within groups. The seed derived from these bulks will provide further material for selection in 1957 and certain groups will go to Wad Medani for more complete examination in V.T.'s.

No further backcrossing to Sakel types is contemplated since each backcross on the average dilutes the gain in ovule number factors by half. Lines now exist which vary in content between three and six backcross generations. A Panmixis Nucleus, which will comprise a bulk of all useful material selected to date, irrespective of pedigree, will be planted in the coming season, 1957, to provide a pool of "high ovule" genetic material. The components of the nucleus in nearly all cases contribute equal parts. This bulk will be brush panmixed for two generations each year continuously, and at the same time single plant selections will be taken on a basis of ovule number and lint length assessments. Selections satisfying the standards set up will be multiplied to provide seed for V.T.'s at Medani.

Exploitation of Wild Species.

G. anomalum. One family stemming from a *G. anomadense* × BAR 14/25 cross showed genetic disturbance which could be attributed to *anomalum* genes. It was also hairy, this character coming from *anomalum* since BAR 14/25 is virtually hairless. Seed from backcrosses to BAR 14/25.4 were grown out-of-season and 153 plants were chosen for selfing as the result of characteristics which appeared to be influenced by *anomalum* genes. The parent plants of these backcrosses were selfed and the resulting progenies will be studied in the coming season. Of particular interest are the progenies carrying *anomalum* hair genes since ultimately homology tests will be made with H_1 and H_3 found in the New World Cottons.

G. anomalum and *G. triphyllum.* These are the only two species allocated to the B genome, and *triphyllum* is only recently known and has been little studied. A transference of *triphyllum* characters to *anomalum* for comparison with that species has been undertaken. It is of interest that although these two species cross readily and give viable F_1 seed, *triphyllum* rarely sets seed at Shambat although *anomalum* does so very easily.

Bract Studies.

Characteristics of bracts are being studied within diploid species in order to elucidate the type of inheritance which controls them. In particular, size and number of teeth are of interest, as is also the flaring or non-flaring of bracts.

High Lint Strength Transference from G. thurberi.

This transference is now in its 12th generation from *G. thurbadense* and consists of 3 lines respectively 2nd, 3rd, and 4th backcrosses to Sakel and each interspersed with the complementary number of self-bred generations. Investigation of the genetics of this lint strength has been hampered by the necessity to use most of the available Pressley Index testing capacity solely for the purpose of picking out the strongest linted plants for carrying on the transference.

Bulked self bred seed from the selected best families in the 2nd and 3rd backcross lines has been prepared for a test at Medani of the lint characters and cropping of these stocks. It is hoped that tests next season on the segregating families obtained from the 4th backcross will indicate the genetic composition of this strength factor.

The following table summarizes the results to date:

	Mean strength of family as % of control variety.		
Year	*2nd b/c.*	*3rd b/c.*	*4th b/c.*
1949	123*		
1950	116		
1951	113		
1952	114		
1953	104	108	
1954	109	110	
1955	107	109	109
1956	ca 108	ca 109	103 (segregating ¾–107 % ¼– 97 %)

*Individual plant.

Bollworm Resistance.

The fruits of last year's light bollworm attack were reaped this season in the form of many families misclassified for expected resistance and susceptibility.

Three of the 2nd b/c. strains from *G. thurberi* to BAR 11/7 appeared to be homozygous for bollworm resistance and are being carried on for further testing and propagation. Using the index of resistance (see Report 1954-55, p. 15) calculated for each plant to give a mean value for each family, these families obtained the following scores as percentages of the control susceptible variety, BAR 11/7.

PE 30/56 145% of control
PE 31/56 147% of control
PE 38/56 139% of control

Several of last year's families were grown from natural seed in which there occurred apparently resistant *barbadense* outcross plants. The most promising of these were backcrossed again to *barbadense* in the hope that this would provide a quick transference of the resistance. In every case the resulting families were fully susceptible. The direct transference to *barbadense* through family PE 96/55 (last year's report, p. 18) has ended in sterile and completely susceptible families.

From the 5th backcross to BAR 11/7 three strains will be selfed out next season and also carried on to further backcrosses.

In the transference from *armadense,* two 1st backcross lines are being continued.

Leafcurl.

A very heavy leafcurl attack developed on all breeding plots and reduced seed production very considerably. The only place which escaped was Riverside plot. It was planted with F_2 and backcross families from Medani which were to be filtered for leafcurl resistance. Only a very slight attack developed in spite of every encouragement, and the whole plot has been ratooned for another attempt next season. Large scale budding with leafcurl infected buds was carried out. The percentage of successful 'takes' was 53% of early budded plants and 21% in late budding.

About 12 plants have so far been found in which the infected bud has grown but has failed to infect the plant.

A set of F_3 families from the cross BLR 14/16 × BAR 14/25 showed an encouraging level of resistance to leafcurl. Data were not available from the F_1 and F_2 families, since the cross was made for blackarm resistance transference, but the following information was extracted from the records:

F_2	Of 149 selected plants 75 developed leafcurl.			
	No. of l/c plants per row of approx. 45 plants	*Frequency of families of*		
		F_3	BLR 14/16	BAR 14/25
	0-4	47	3	
	5-9	5		1
	10-14	5		
F_3	15-19	4		
	20-24	3		
	25-29	4		2
	30-34	6		
	35-39	2		2
	40-+	6		1

Resistance to leafcurl is being introduced into BAR 14/25 from the L type of cotton which shows only 25% susceptibility. Supplementary to this is a longer term transference of leafcurl resistance from *G. hirsutum*; this is already well under way. Two *hirsutum* parents were chosen, neither of which has yet been reported with leafcurl; they are MU8b and Ferguson. These strains were first crossed to the L cotton and then backcrossed to it. At this point a dichotomy was made in the backcross programme in order that half of each family should continue to backcross to L and that the other half cross to S types. In order to lose as little of the *hirsutum* resistance as possible the crossing is being carried out on large families, the hybrid material being the female parent and the number of crossbred bolls per plant being limited to one. Seed is being harvested as late as possible in order that each plant may have the maximum chance of developing leafcurl. Where this happens the seed is discarded. The four bulks resulting from this year's work will be backcrossed once more, as appropriate, to S or L cotton before being subject to a programme of brush panmixis and roguing for leafcurl susceptibles and off-types. Further backcrossing may be necessary in the interests of quality at a later date.

Miscellaneous.

In England Professor Harland had produced a doubled haploid plant of Montserrat Sea Island which would not flower. Cuttings were flown by post in a polythene bag and arrived perfectly fresh. The cuttings died, but buds from them inserted into Sakel seedlings produced 3 plants from which selfbred seed has been returned to Manchester.

The type collection of *punctatum* cottons was backcrossed to Stoneville doubled haploid and the F_1's will be tested in the coming season for the presence of semi-sterile pollen. This experiment is to try to detect modern chromosome translocations in this group of cottons.

Diseases and Pests.

The natural blackarm attack was widespread and severe this year, and wet leaf, bracteole and boll lesions were still present at the end of December on the in-season cotton.

Aphids, whitefly, jassid and bollworms were not more troublesome than usual.

Leafcurl was widespread and completely sterilized the tops of the plants.

KADUGLI STATION

BY

M. F. ROSE, A. LOW AND HAMDAN EFF. HANNAY.

The Commercial Crop.

In spite of the fact that rainfall for the Jebels area was above average, distribution and intensity of precipitation were very variable. Rains generally were late in arriving with heavy storms in August and September. Following the establishment of his food crops, the cultivator was forced into late planting and much difficulty was experienced in obtaining good final stands. Heavy storms washed out much of the young crop and large areas adjacent to khors were continuously waterlogged. Weeding was also delayed, in many cases entirely neglected. Relevant meteorological data are shown below:—

Rainfall (mm.) Nuba Mountains, 1956.

Station	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Total*	*Average*
Kadugli	5·0	22·5	136·5	93·3	144·5	219·0	63·5	684·3	759
Dilling	—	18·0	111·0	128·0	194·0	147·5	91·0	689·5	679
Lagowa	—	10·0	98·0	116·0	244·0	234·0	95·0	797·0	698
Talodi	36·0	101·0	132·5	140·0	187·0	200·0	98·0	894·5	818
Kalogi	41·0	14·0	141·0	197·5	245·0	129·0	102·5	870·0	778
Abu Gubeiha	—	44·0	64·0	162·0	268·0	138·0	63·0	739·0	710
Um Berembeita	—	37·0	154·0	120·0	212·0	112·0	76·0	711·0	650
Abbassiya	—	18·0	83·5	178·0	128·0	173·0	21·5	602·0	694
								748	723

Temperatures °F. (Kadugli).

	Mean Max.	*Range*	*Mean Min.*	*Range*
Period Resting Dec. '55–May '56	101	105–93	68	74–60
Period Growth June '56–Nov. '56	92	96–83	71	77–66

The total allocation of seed was 86,000 small kantars* but only 75,000 were taken up. In point of fact it is extremely doubtful whether this amount was planted. Discontent at the prices† ruling for seed cotton in the previous season must in part account for the low acreage, with the cultivator turning his attention to food and alternative cash crops. A crop of 336,500 small kantars of seed cotton was eventually marketed, which shows a still further decline on the record year of 1954-55 when 906,000 were ginned. In view of the fact that new Murray saw gins (diesel driven) are now being installed throughout the area capable of dealing with a crop of from $1\frac{1}{2}$-2 million small kantars, this general apathy toward cotton is a matter of some concern.

*1 small kantar=100 rotls=99 lb.

†Grade I=LS1.800. Grade II=LS1.700. Grade III=LS1.400 per small kantar.

Blackarm, though noted on the variety trials, was barely reported throughout the area. *Ramularia* was again present and high infection was reported on the Abu Gubeiha variety trial. It would appear from the table given below that both Pump Scheme Strain and its derivative BAR 11/7 show an increased susceptibility over that of the other varieties with a marked 'place' effect at Abu Gubeiha. Although no actual counts were taken in the previous season, severe infection was reported there both on the trial and in the surrounding area, suggesting some environmental factor predisposing the plants to attack.

% Infection Ramularia in Variety Trials.

	Abu Gubeiha	*Talodi*	*Mean*
BAR 7/8.2	42	32	37·0
BAR 7/8.1	39	36	37·5
Wilds SUS 16/1	36	36	36·0
BAR 11/7	80	37	58·5
PSS	73	38	55·5
Mean	54·0	35·8	44·9
S.E. (Mean)	6·0	Non-signif.	
Diff. 1% level	23·4		

Pests were widespread with pink and spiny bollworm predominating. In January, counts taken in the Kalogi-Talodi area showed an incidence of 40-50%, at Kadugli 25% and in the Dilling area 5%. Sudan bollworm was present at the flowering stage though the actual damage ascribed to this pest was not severe. The intensity of bollworm attack has been related to the steady increase of stand-over cotton throughout the Jebels. Flea beetle attack was again widespread, in many cases causing defoliation of mature plants. Millepedes and termites also took their toll of the crop by depleting stands.

Breeding.

(a) The 'Testing Phase' of BAR 11/7 (a balanced lattice of 9 replications and 68 progenies) was brought to a successful conclusion following complete failure through drought in the previous season. The trial averaged 1,168 lb. of seed cotton and 388 lb. of lint per acre.

Following analysis, 21 progenies were retained, 6 showing an increase in lint of 8% and 15 an increase of 5% over parental control. The selfed seed of these progenies (Breeding Phase 1954-55) will be bulked and grown in isolation as BAR 11/7.1 while their bulked natural seed will appear in the standard trials in the coming season.

(b) BAR 7/8.3, selected for reduced seed coat nep in 1954-55 (see history in 1955-56 Report) was compared directly with BAR 7/8.1 in the Kadugli variety trial. Five random samples (5 × 100 seeds) per plot of the two strains in question were taken at the gin (roller) and

the percentage of seed coat nep determined. These were 47·2% and 38% for BAR 7/8.1 and BAR 7/8.3 respectively. This reduction was significant at the 5% level and indicates that with a single filter an immediate improvement can be effected. Saw ginning on bulk material from the same trial gave figures of 5% (BAR 7/8.1) and 2·5% (BAR 7/8.3).

Further work within BAR 7/8.3 was continued and 318 progeny rows, each with its appropriate control, were analysed. Thirty-five lots, each showing at least 10 units reduction in seed coat nep when compared with its own control, were finally accepted and these will be bulked in the coming season to give BAR 7/8.4.

(c) Work on the transference of intrinsic fibre strength from Hopi Acala to BAR 7/8.2 and BAR 11/7 and an attempt to combine quantity and quality in the cross BAR 7/8.2 × BAR 11/7 was conducted at Medani (see G.R.S. Report).

Testing.

Kordofan.

Variety trials were laid down at Kadugli, Talodi, Dilling, Lagowa and Abu Gubeiha on 13th, 14th, 11th, 9th and 14th July respectively. At the Dilling site two re-sowings were necessary but elsewhere establishment was not difficult. Layout followed the standard pattern, a 6 × 6 Latin square at Kadugli of plot size 0·023 acres and randomized blocks of 8 replications, plot size 0·026 acres, at the other four sites. Spacing at all sites was 90 cms. × 45 cms. with 3 plants per hill at final thinning.

Apart from Kadugli, yields generally were below average. This can be ascribed to the very heavy rainfall in August and September, subsequent water logging and strong weed growth.

In terms of mean yield, BAR 7/8.2 gave the highest return of seed cotton and lint per acre outyielding its nearest rival BAR 7/8.1 by 13% (lint). Its performance over years and at the many experimental sites throughout the Sudan has shown a consistent superiority over BAR 7/8.1 and were it not for the fact that a major change in type to BAR 11/7, a quality type, is envisaged for the Jebels area the wholesale replacement of BAR 7/8.1 by BAR 7/8.2 would be immediately effected.

Although BAR 11/7 outyielded Pump Scheme Strain by 7% (lint) at Kadugli, the overall comparison was disappointing. However, no serious blackarm was reported on any of the trials.

At the request of the Department of Agriculture, Wilds SUS 16/1 made its first appearance in the Kordofan trials. This quality type, adapted over many years to irrigation, was not severely tested by

VARIETY TRIALS. NUBA MOUNTAINS, 1956-57.

YIELD SEED COTTON AND LINT IN LB. PER ACRE.

	Kadugli			*Talodi*			*Lagowa*			*Dilling*			*Abu Gubeiha*			*Overall Mean*		
	S/c	*Lint*	*G.O.T.*	*S/c*	*Lint*	*G.O.T.*	*S/c*	*Lint*	*G.O.T.*	*S/c*	*Lint*	*G.O.T.*	*S/c*	*Lint*	*G.O.T.*	*S/c*	*Lint*	*G.O.T.*
BAR 7/8.1	1240	429	34·6	595	198	33·3	309	109	35·3	668	233	34·9	517	178	34·4	666	229	34·4
BAR 7/8.2	1355	473	34·9	716	244	34·1	399	140	35·1	712	252	35·4	522	180	34·5	741	258	34·8
BAR 7/8.3	1244	433	34·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BAR 11/7	1183	367	31·0	478	143	29·9	321	103	32·1	649	213	32·8	491	157	32·0	623	197	31·6
PSS	1136	342	30·1	530	159	30·0	330	101	30·6	682	208	30·5	543	164	30·2	644	195	30·3
Wilds SUS 16/1	1290	414	32·1	628	194	30·9	325	106	32·6	696	229	32·9	499	166	33·3	688	222	32·3
S.E. (Mean)	21			9			8			11			6					
Difference (P=0·05)	61			25			23			Not significant			Not significant					

TABLE 5.

EQUATORIA AND DARFUR COTTON VARIETY TRIALS, 1956-57.

SEED COTTON AND LINT IN LB./ACRE.

	Yambio						*Darfur*		
	S/c	*Lint*	*G.O.T.*	*S/c*	*Lint*	*G.O.T.*	*S/c*	*Lint*	*G.O.T.*
BAR 7/8.2	1003	380	39·1	830	324	39·1	1906	614	32·2
BAR 7/8.1	948	371	39·1	945	370	39·1	1657	507	30·6
BAR SP84	861	297	34·5	836	288	34·5	1230	347	28·2
BAR 11/7	952	306	32·2	802	258	32·2	1230	381	31·0
BAR 11/5	836	269	32·2	809	261	32·2	—	—	—
PSS	810	242	29·9	703	210	29·9	863	229	26·6
S.E. (Mean)	10			15			37		
Sign. Diff. (P=0·05)	30			44			107		
	1st year land			2nd year land					
	(Planted 11.6.56. Pickings 7, from 31.10.56)						Planted 1.7.56. Picked from end October		
	6 Varieties × 6 replications			6 Varieties × 5 replications			5 Varieties × 7 replications		

local conditions and relatively good yields were obtained. How far lint quality* has been impaired by saw ginning will be evident from spinning test reports.

The results of the Kordofan trials are shown in Table 4.

Tozi, Darfur and Equatoria.

Reports from Tozi indicate that severe storms followed by washaways severely affected both the standard variety trial and the spacing trial. Marked physiological wilt, ascribed to abnormality in rainfall distribution, added further to the general irregularity of all experimental cotton. In consequence Tozi data have not been accepted. Results from Darfur (1) and Yambio (2) are combined in Table 5.

Miscellaneous.

Ridging versus Flat Cultivation.

As in the previous season, two randomized block experiments of four replications each were laid down at Dilling and Talodi. The original intention was to test out the three main treatments, Ridged (R), Ridges Tied (RT) and Flat (F) using BAR 7/8.3 seed only and ignoring the split-plot layout of the previous season in which Pump Scheme Strain was used as the susceptible control. However, at the request of the Manager, N.M.C.I., three seed dressings (against blackarm) were superimposed on these main treatments. The experiment thus suffers from the defect that no fully susceptible type is included to gauge natural infection and the figures shown below merely point to any further advantage in dressing material already resistant.

A highly significant difference in lint per acre was shown by 'Flat' over 'Ridged' and 'Ridges Tied', a trend which has been consistent over 3 years in five experiments. Apart from controlling sheet erosion, such cultural methods prior to sowing would appear to decrease rather than increase final yield.

Counts showing both frequency and intensity of blackarm infection on the sub-treatments were made six weeks after planting. Figures shown in the generalized table below indicate very light blackarm intensity, and although percentage infection has been reduced by the seed dressings no advantage has accrued in final yield. Taken in conjunction with those of the previous season, these figures indicate that there was no economic return in dressing B_2 B_3 material, and

*Effective length $\frac{44\text{-}46}{32}$nd inch.

that copper formulations were less effective in controlling blackarm on the seed and in the seedling stage than mercurials.

LINT (LB./ACRE).

	Talodi (895 mm.)	*Dilling* (690 mm.)
R	204	181
RT	196	171
F	257	227
S.E. (Mean)	6	7
Diff. 1% level	31	35

MEAN BLACKARM GRADE AND % INFECTION 6 WEEKS FROM SOWING.

	Talodi		*Dilling*		*Talodi*	*Dilling*
Seed Dressing	*Mean grade*	*% infection*	*Mean grade*	*% infection*	*Yield lint lb./acre*	
YF 3824	0·16	13	0·15	4·3	243	190
R 1489	0·15	13	0·01	0·2	238	214
YF 3225	0·3	23	0·04	2·0	223	205
Control	0·56	40	0·40	11·5	230	209

NOTE:—YF 3225 = cuprous oxide/paraformaldehyde.
R 1489 = 10% Hg liquid (MEMA formulation).
YF 3824 = 15% Hg soluble powder (MEMA formulation).
Blackarm grade 0-10 (Knight's classification of increasing intensity).

PROPAGATION.

The whole of the Nuba Mountains was sown to BAR 7/8.1 derived originally from the first wave of seed from the Abu Habl multiplication area. During the present season the Abu Habl grew 3,226 acres of BAR 7/8.1 which included the two nuclei BAR 7/8.1 RR (30 acres) and BAR 7/8.1 R (600 acres). The second main wave of purified seed from this area will be sent to Lagowa for the 1957-58 season.

At El Effein two isolation areas, two acres of Pump Scheme and four of BAR 11/7, were grown for type maintenance.

APPENDIX.

KEY TO SYMBOLS USED IN THIS REPORT.

Egyptian S types.

DS	Domains Sakel originally imported from Egypt.
BAR 14/25	A Sakel type carrying B_2 and B_3. (Formerly BLR)
BAR 14/25.4 and 5	4th and 5th filter for yield. (Formerly BLR)
BAR 14/48	The first Sakel type to carry B_2 B_3 B_6. (Formerly BLR)
G. auritum	A *barbadense* type with high ovule number per loc.
G. armadense	A synthetic hexaploid obtained by crossing *G. armourianum* and *G. barbadense* and doubling the chromosome number of this triploid.

Egyptian L types

X1730A or XA	Successor type to X1730.
XAG	X1730A Gash grown.
XAT	X1730A Tokar grown.

XAT1	1st filter of XAT.
BAR XL1 BAR 1730L1	1st filter of BAR 1730L.
BAR XL3	3rd filter of BAR 1730L.
BAR 4/16	An X1730A type carrying B_2 and B_3.
BAR 5/6	As BAR 4/16 but carrying the red *arboreum* gene R_2^{RS}.
BAR 4/24	An X1730A type carrying B_2, B_3, B_6.
BAR 4/25	An X1730A type carrying B_2, B_3, B_6.
BAR 5/7	As BAR 4/25 but carrying in addition the red *arboreum* gene R_2^{RS}.

American Upland.

BAR SP84	The blackarm resistant component of Uganda SP84.
BAR 7/8.1 BAR 7/8.2	BAR SP84 carrying B_2 and B_3, 1st and 2nd filters.
Pump Scheme Strain (PSS)	An old commercial bulk deriving from Nyasaland Upland.
BAR 11/5	XA129 (PSS) carrying B_2.
BAR 11/7	XA129 carrying B_2 and B_3.
Wilds SUS 16/1	American long staple type: irrigated.
P268F	American importation direct from India.
Hopi Acala	A very early type directly imported from U.S.A., 1953: of high intrinsic fibre strength.
Acala 4.4.2	A high quality American importation, 1955.

Genes.

B_1	A weak dominant blackarm resistance factor from Uganda B31.
B_2	A strong dominant blackarm resistance factor from B31.
B_3	A partially dominant blackarm resistance factor from *G. punctatum*.
B_4	A partially dominant blackarm resistance factor from *G. arboreum*.
B_5	A partially dominant blackarm resistance gene from 'Grenadines White Pollen'.
B_6	A blackarm resistance intensifier from *G. arboreum*.
B_7	A partially dominant blackarm resistance gene from Stoneville 20.
b_8	A recessive blackarm resistance gene from *G. anomalum*.
H_1	A hairiness gene from Tanguis.
H_2	A hairiness gene from *G. tomentosum*.
H_3	A partially dominant hairiness gene controlling the distribution of hairs on the plant.

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